rather be said that plants acquire and display this power only when it is of some advantage to them; this being of comparatively rare occurrence, as they are affixed to the ground, and food is brought to them by the air and rain." The diversity of the power of movement in plants naturally engaged his attention, and the last but one of his works—in some respects perhaps the most remarkable of them—was devoted to showing that these could be regarded as derived from a single fundamental property. "All the parts or organs of every plant while they continue to grow . . . are continually circumnutating." Whether this masterly conception of the unity of what has hitherto seemed a chaos of unrelated phenomena will be sustained time alone will show. But no one can doubt the importance of what Mr. Darwin has done in showing that for the future the phenomena of plant movement can and indeed must be studied from a single point of view.

Along another line of work Mr. Darwin occupied himself with showing what aid could be given by the principle of natural selection in explaining the extraordinary variety of detail in plant morphology. The fact that cross-fertilisation was an advantage, was the key with which, as indicated in the pages of the "Origin of Species," the bizarre complexities of orchid flowers could be unlocked. The detailed facts were set out in a well-known work, and the principle is now generally accepted with regard to flowers generally. The work on insectivorous plants gave the results of an exploration similar in its object and bringing under one common physiological point of view a variety of the most diverse and most remarkable modifications of leaf-form.

In the beginning of this article the attempt has already been made to do justice to the mark Mr. Darwin has left on the modern study of geographical botany (and that implies a corresponding influence on physio-palæontology). To measure the influence which he has had on any other branches of botany, it is sufficient to quote again from the "Origin of Species":—"The structure of each part of each species, for whatever purpose used, will be the sum of the many inherited changes, through which that species has passed during its successive adaptations to changed habits and conditions of life." These words may almost be said to be the key-note of Sachs's well-known text-book, which is regarded as the most authoritative modern exposition of the facts and principles of plant-structure and function. And there is probably not a botanical class-room or work-room in the civilised world, where they are not the animating principle of both instruction and research.

Notwithstanding the extent and variety of his botanical work, Mr. Darwin always disclaimed any right to be regarded as a botanist. He turned his attention to plants doubtless because they were convenient objects for studying organic phenomena in their least complicated forms; and this point of view, which if one may use the expression without disrespect, had something of the amateur about it, was in itself of the greatest importance. For, from not being, till he took up any point, familiar with the literature bearing on it, his mind was absolutely free from any prepossession. He was never afraid of his facts or of framing any hypothesis, however startling, which seemed to explain them. However much weight he attributed to inheritance as a factor in organic phenomena, tradition went for nothing in studying them. In any one else such an attitude would have produced much work that was crude and rash. But Mr. Darwin—if one may venture on language which will strike no one who had conversed with him as overstrained—seemed by gentle persuasion to have penetrated the reserve of nature which baffles smaller men. In other words, his long experience had given him a kind of instinctive insight into the method of attack of any biological problem, however unfamiliar to him, and he rigidly controlled the fertility of his mind in hypothetical explanations by the no less fertility of ingeniously-devised experiment. Whatever he touched he was sure to draw from it something that it had never before yielded, and he was wholly free from that familiarity which comes to the professed student in every branch of science, and blinds the mental eye to the significance of things which are overlooked because always in view.

The simplicity of Mr. Darwin's character pervaded his whole method of work. Alphonse de Candolle visited him in 1880 and felt the impression of this. "He was not one of those who would construct a palace to lodge a laboratory. I sought out the greenhouse in which so many admirable experiments had been made on hybrids. It contained nothing but a vine." There was no affectation in this. Mr. Darwin provided himself with every resource which the methods of the day or the mechanical ingenuity of his sons could supply, and when it had served its purpose it was discarded. Nor had he any prepossession in favour of one kind of scientific work more than another. His scientific temperament was thoroughly catholic and sympathetic to anything which was not a mere regrinding of old scientific dry bones. He would show his visitors an *Epipactis* which for years came up in the middle of a gravel walk with almost as much interest as some new point which he had made out on a piece of work actually in hand. And though he had long abandoned any active interest in systematic work, only a few months before his death he had arranged to provide funds for the preparation of the new edition of Steudel's Nomenclator, which, at his earnest wish, has been projected at Kew.

(*To be continued.*)

MASCART AND JOUBERT'S "ELECTRICITY AND MAGNETISM"

Leçons sur L'Électricité et la Magnetisme. Par E. Mascart et J. Joubert. Tome I. (Paris, 1882.)

MANY of our readers must already be familiar with the "Électricité Statique" of M. Mascart. They will therefore turn with high expectations to the perusal of the "Leçons sur l'Électricité et le Magnétisme," of which he is one of the authors. On the whole they will not be disappointed. They will find in it all the limpid clearness, all the vivacity, all the elegance of presentation, both spiritual and material, that characterise the best French text books; and they will find withal none of the shallowness with which their grudging admirers have been wont to credit them. It is a wonderful national gift that our Gallic neighbours have—their power of scientific exposition. We Britons, with a stray exception, are far behind them; still farther are our German cousins. Notwithstanding our undoubted kinship in language and descent with the Germans, and all our well-founded appreciation of their excellence, we weary of their very virtues. One turns from their copious Gründlichkeit, as from the indispensable *labour* of life, and one finds in the reading of a good French text-book a never-failing *pleasure*.

Only the first volume of the Leçons is as yet before us, and some of our criticisms may have, on that account, to be taken with allowance; for the head, however important, is not the whole body. We see at once that there is little in common between them and the "Électricité Statique;" the plan of the work, so far as it has gone, is quite different. It originated, so the preface tells us, in the lectures of one of the authors at the Collège de France. The first volume is general and theoretical; the second is to be special and practical. As to the propriety of such an arrangement, much depends on the class of students to which it is addressed. If it is meant for such as have already a considerable knowledge of electrical phenomena, and some practice in accurately conceiving and describing them, then the plan is good. If. on the other hand, the reader is supposed to be a beginner in electrical science, knowing nothing of the phenomena, but furnished merely with the requisite mathematical knowledge, then we do not think well of it. We prefer in that case, the arrangement of the "Electricité Statique," that is, a fuller account of the phenomena upon which the fundamental principles rest, with a mathematical treatment sufficient to prevent vagueness of impression, and thereafter a detailed deductive account of the consequences of the fundamental principles, and a full description of the phenomena irrespective of their agreement or disagreement with theory. Assuming that we have to deal with a student, who has the first element of a physicist, viz. a tolerable mathematical education, perhaps the greatest danger to be avoided is formalism, or blind swearing, *in verba magistri*. Nothing is more likely to encourage this, than hurried and hasty discussion of fundamental facts. Nothing in reality is gained by driving the learner express to the law of the inverse square, and then leisurely expounding its consequences. Far better, that we should first secure for him a thorough qualitative understanding of the natural phenomena; and then teach him how they can be built together upon an abstract frame-work, whose lines they will follow, not necessarily with absolute coincidence. The learner must be taught at the very outset that analysis is the servant and not the master of the physicist; and that a physical idea is not always simplified by clothing it in an analytical suit of buckram. This much as a warning to possible students of this volume.

With one feature of the plan of these Leçons we must express unqualified satisfaction; that is the adoption of the methods of Thomson and Maxwell. At times these are so closely followed that the paragraphs are little more than translation; at other times considerable changes, chiefly in the way of simplification, are introduced. At the same time, the authors have not scrupled to borrow from other sources, where good material was to be had. They have gone on the principle of Molière, "je prends mon bien où je le trouve"; and rightly, for scientific light (unlike political or theological), is not supposed to be the property of one sect or one country. The English reader will not find much that is new, or perhaps we should say not accessible to him in his own language, however much he may learn as to arrangement and demonstration. Originality apparently is not aimed at; the authors put before their readers such of the modern development of electrical theory as they deem most important in themselves, or most likely to be useful to the physicist. We are of opinion that their selection on the whole has been judicious; and therein lies the chief merit of the book. It will, therefore, fill a great gap in French scientific literature. Possibly the second volume may help to fill the corresponding gap in the experimental part of the subject, which exists, unfortunately, in English as much as in French literature.[1] How urgently such treatises are wanted, and how ignorant one nation may be of what is common-place to another, is well exemplified by the fact that a distinguished *savant* like Prof. Clausius lately published, both in *Wiedemann's Annalen* and in the *Philosophical Magazine*, as something new and noteworthy, the theorem of mutual potential energy and certain consequences therefrom, that have been familiar to us ever since we knew anything of electrical theory, *i.e.* some ten years or more.[2]

We are thus led to notice the one serious defect of this treatise—the entire want of all references to original sources of information. These Leçons can have been meant only for those that contemplate a special study of electricity or original work of some kind bearing upon it; for such learners knowledge at first hand in some degree is essential; and who is to lead the scientific sheep to the water-springs if their responsible shepherds do not? We are well aware, from bitter experience, of the drudgery involved in this part of book-making, and of the difficulty, with all care, of being absolutely accurate and just; but utter neglect of the duty is inexcusable. Here is a provoking instance. The reader is aware that there are two different ways of representing the action of a mass of polarised molecules:—First, by a volume and a surface-distribution of attracting centres; second, by a surface distribution alone. The first of these is undoubtedly due to Poisson. The second is continually used in German books, and attributed to Gauss (the first method, and Poisson with it, they mostly ignore). Now MM. Mascart and Joubert add to the diversity by quoting the second method as Poisson's. It is certainly news to be told that Poisson knew of any such general theorem, and a cursory re-examination of his memoirs failed to find it. Until the exact reference is given, we must hold our previous conviction that the theorem in question was virtually first given by Green in his essay on "Electricity and Magnetism" (Nottingham, 1828). It was discovered independently by Gauss, whose statement of it (the first explicit one) is given in Art. 2, "Intensitas Vis Magneticæ, &c.," read December, 1832, to the Royal Society of Göttingen. His demonstration is given in Art. 36 of the "Allgemeine Lehrsätze, &c." Again, the corollaries from Gauss' Theorem of Mutual Potential Energy in Art.

---

[1] The Germans have the admirable treatise of Wiedemann, which, in its forthcoming shape, with electrostatics added, will be the greatest experimental treatise on electricity in existence.

[2] The theorem is simply a particular discrete form of Green's theorem; and in this shape was originally given by Gauss in his "Allgemeine Lehrsätze, &c." In one point of view it is simply a property of homogeneous functions of the second degree, and plays a part in many branches of mathematics, *e.g.* curves and surfaces of the second degree, theoretical dynamics, strains and stresses, &c.

63 *may* have been originally drawn by M. Bertrand; but, as no reference is given, we cannot meantime be sure whether his claim is any better than that of Clausius.

Detailed analysis being clearly out of place here, we conclude with a few running comments on the different parts of the work. The first part deals with Electrostatical Phenomena. Except that we think the introductory chapter somewhat hurried and meagre, we commend the general simplicity of the arrangement. A quasi-physical proof of most of the general propositions concerning electrified systems is given, and, we think, in the interest of the physical reader, that this is right. The seventh chapter of this part is especially recommended to the notice of our readers; there, so far as we know for the first time, Sir W. Thomson's theory of dielectrics finds its place in a text-book on Electrostatics; both here and in the corresponding chapters on Magnetism the authors show a complete appreciation and mastery of this important step in mathematical physics. Until Maxwell's treatise was written, this piece of Thomson's work had been apparently forgotten. It has lately been taken up in Germany, more especially by Helmholtz *more suo*. This neglect is no doubt to be explained by the equal neglect of the ideas of Faraday, of which Thomson's theory is the mathematical embodiment. The errors one occasionally finds on this subject in continental text-books of authority are very surprising, *e.g.* it will be found stated that a small sphere of magnetic or diamagnetic substance tends to move *along the lines of force;* the better diffusion of the true theory will surely tend to prevent such fundamental mistakes as this. The application of Thomson's theory to dielectrics is most interesting and important theoretically; but great difficulty has been found in verifying it experimentally, owing to the scarcity of bodies that will insulate sufficiently well. Its application to magnetics has been most successful, as our readers doubtless know.

The second part treats of electric currents, stationary and variable, and will probably be found well suited for the higher class of practical electricians; the account of the theory of telegraphic signalling deserves special mention. In Chapter II. of this part the authors are more cautious as to Volta's law of contact than they are at the end of the former part, knowing doubtless, as sound practicians, that they are on delicate ground.

The theory of magnetism, which constitutes the third part, suffers, as did the electrostatics, in the beginning, from the suppression of experimental detail. We cannot reconcile ourselves to the definition given of the magnetic axis as the line joining the poles of the magnet. This seems a very artificial and difficult way of introducing this fundamental conception; and we do not see the advantage over the ordinary method, which defines it as that direction which is always found parallel to a certain fixed vertical plane when the magnet is suspended freely under the earth's action alone at a given time and place. We also fail to see why, in mentioning the hypotheses advanced to explain terrestrial magnetism, Gilbert and Biot should be mentioned, and Halley and Hansteen forgotten. In other respects, this part of the work gives as good an account of its subject as most treatises we have seen. Our readers may note the discussion of the direct magnetic action of the heavenly bodies as something fresh in a text-book.

The last part of the work deals with Electro-magnetism. The connection between a current and the equivalent magnetic shell is deduced in a very ingenious (although we scarcely think simple) way from the law of Biot and Savart. The other method, which we prefer, is also given, in which the elementary proposition is that a plane circuit, whose linear dimensions are infinitely small compared with the distance of the point at which its action is considered may be replaced by a small magnet. A separate chapter is very properly given to the Methods of Ampère, and the authors have shown their judgment in refraining from loading their pages with the various solutions of the indeterminate problem to find the elementary law of electrodynamic action of which we have lately had a superfluity. An excellent account is given of the general theory of Maxwell. The only thing we would take objection to is yet another meaning given to that overburdened word Electromotive Force; the authors use *Force Electromotrice Totale* in place of Maxwell's *Vector Potential.* The deduction of the rotation of the plane of polarisation from Hall's phenomenon is given; but Prof. Rowland's name is not mentioned in connection with it; although we are under the impression that it was first given by him in the *American Journal of Mathematics.*

In a supplementary chapter some examples are given of the application to electrical phenomena of the principles of Carnot. Certain of these, due to M. Lippmann, are ranged under the somewhat high-sounding title of the Conservation of Electricity. We are a little inclined to question the propriety of this phrase; but we are certainly obliged to MM. Mascart and Joubert for a succinct account of what we are to understand by it.

We shall look with much interest for the second volume of this work, in which, among other things of interest to practical electricians, we are promised a discussion of the efficiency of electric generators and electromotors, a subject on which the recent experience of the authors at the Paris Exhibition must have well qualified them to give an opinion.

G. C.

OUR BOOK SHELF

Die Gasteropoden der Meeres-ablagerungen der ersten und zweiten miocänen mediterran-stufe in der Oesterreichisch—Ungarischen Monarchie. Von R. Hörnes und M. Auinger. Lieferung 1, 2, 3. (Vienna: Hölder, 1879-1882.)

A MERITORIOUS and useful contribution to our knowledge of the tertiaries of middle Europe. The first-named author is the worthy son of a worthy sire, the late Prof. Hörnes, whose work on the fossil shells of the Vienna Basin is so familiar to palæontologists. The total number of species hitherto described or noticed in the present publication is 220, including 94 new species or forms. Out of all this number 11 only are given as recent or living; and two more may be added (viz. *Nassa semistriata* and *Columbella corrugata* of Brocchi), which inhabit the Mediterranean as well as the North Atlantic. These recent species have survived from the Miocene epoch—a period of incalculably remote antiquity—without the slightest change. The rest may be regarded as the οἱ πλέονες in the same sense as we use euphemistically for our dead. Perhaps some more fossil species may be hereafter iden-